National Institute of Environmental Health Sciences

Climate-based models for understanding and forecasting dengue epidemics

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Abstract:

BACKGROUND: Dengue dynamics are driven by complex interactions between human-hosts, mosquito-vectors and viruses that are influenced by environmental and climatic factors. The objectives of this study were to analyze and model the relationships between climate, Aedes aegypti vectors and dengue outbreaks in Noumea (New Caledonia), and to provide an early warning system. METHODOLOGY/PRINCIPAL FINDINGS: Epidemiological and meteorological data were analyzed from 1971 to 2010 in Noumea. Entomological surveillance indices were available from March 2000 to December 2009. During epidemic years, the distribution of dengue cases was highly seasonal. The epidemic peak (March-April) lagged the warmest temperature by 1-2 months and was in phase with maximum precipitations, relative humidity and entomological indices. Significant inter-annual correlations were observed between the risk of outbreak and summertime temperature, precipitations or relative humidity but not ENSO. Climate-based multivariate non-linear models were developed to estimate the yearly risk of dengue outbreak in Noumea. The best explicative meteorological variables were the number of days with maximal temperature exceeding 32 degrees C during January-February-March and the number of days with maximal relative humidity exceeding 95% during January. The best predictive variables were the maximal temperature in December and maximal relative humidity during October-November-December of the previous year. For a probability of dengue outbreak above 65% in leave-one-out cross validation, the explicative model predicted 94% of the epidemic years and 79% of the non epidemic years, and the predictive model 79% and 65%, respectively. CONCLUSIONS/SIGNIFICANCE: The epidemic dynamics of dengue in Noumea were essentially driven by climate during the last forty years. Specific conditions based on maximal temperature and relative humidity thresholds were determinant in outbreaks occurrence. Their persistence was also crucial. An operational model that will enable health authorities to anticipate the outbreak risk was successfully developed. Similar models may be developed to improve dengue management in other countries.

Source: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3279338

Resource Description

Exposure :

weather or climate related pathway by which climate change affects health

Meteorological Factors, Precipitation, Temperature

Temperature: Fluctuations

Geographic Feature: ☑

resource focuses on specific type of geography

Ocean/Coastal

Geographic Location: ☑

resource focuses on specific location

Non-United States

Non-United States: Australasia

Health Impact: ☑

specification of health effect or disease related to climate change exposure

Infectious Disease

Infectious Disease: Vectorborne Disease

Vectorborne Disease: Mosquito-borne Disease

Mosquito-borne Disease: Dengue

Mitigation/Adaptation: ☑

mitigation or adaptation strategy is a focus of resource

Adaptation

Model/Methodology: ☑

type of model used or methodology development is a focus of resource

Exposure Change Prediction

Resource Type: ☑

format or standard characteristic of resource

Research Article

Timescale: ☑

time period studied

Short-Term (

Vulnerability/Impact Assessment: ☑

resource focus on process of identifying, quantifying, and prioritizing vulnerabilities in a system

A focus of content